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[Name of Document] Specification 1

[Name of Document] Drawing(s) 1

[Name of Document] Abstract 1

[Proof YES/NO] YES

[NAME OF DOCUMENT] SPECIFICATIONS

[TITLE OF THE INVENTION] AUTOMATIC ANALYZER

[WHAT IS CLAIMED]

1. An automatic analyzer comprising;

(1) an analyzer unit to analyze the components of a specimen to be analyzed,

(2) a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

(3) a controller to administer and control the entire system including said analyzer unit,

(4) an agitator installed on the side of the reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave and a reflecting means to reflect ultrasonic wave from said ultrasonic generators and to irradiate lower ultrasonic wave toward the liquid level of liquid mixture from the bottom of said reaction vessel, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure

by coordination between said lateral ultrasonic wave and lower ultrasonic wave, and

(5) an ultrasonic generator drive circuit to supply drive power to said ultrasonic generator.

2. An automatic analyzer comprising;

(1) an analyzer unit to analyze the components of a specimen to be analyzed,

(2) a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

wherein the bottom is inclined with respect to said liquid mixture level to serve as an ultrasonic wave reflecting means,

(3) a controller to administer and control the entire system including said analyzer unit,

(4) an agitator installed on the side of the reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure

by coordination between lower ultrasonic wave and said lateral ultrasonic wave;

wherein said lower ultrasonic wave is generated when ultrasonic wave generated from said ultrasonic generator is reflected against the bottom of said heat insulating bath, and said lower ultrasonic wave is irradiated from the bottom of said reaction vessel toward the liquid mixture level, and

(5) an ultrasonic generator drive circuit to supply drive power to said ultrasonic generator.

3. An automatic analyzer comprising;

(1) an analyzer unit to analyze the components of a specimen to be analyzed,

(2) a reaction vessel storing the specimen for analysis and liquid mixture with reagent or the like, wherein the bottom is inclined with respect to said liquid mixture level to serve as an ultrasonic wave reflecting means,

(3) a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

(4) a controller to administer and control the entire system including said analyzer unit,

(5) an agitator installed on the side of the reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure by coordination between lower ultrasonic wave and said lateral ultrasonic wave;

wherein said lower ultrasonic wave is generated when ultrasonic wave generated from said ultrasonic generator is reflected against the bottom of said reaction vessel, and said lower ultrasonic wave is irradiated toward the liquid level of said liquid mixture stored in said reaction vessel, and

(6) an ultrasonic generator drive circuit to supply drive power to said ultrasonic generator.

4. An automatic analyzer according to any one of the Claims 1, 2 and 3 characterized in that the material of said ultrasonic wave reflecting means has acoustic impedance different from that of the heat insulating medium in the heat insulating bath which transmits ultrasonic wave generated from the ultrasonic generator.

5. An automatic analyzer according to any one of the Claims 1 and 2 characterized in that said ultrasonic wave reflecting means has a mechanism to change the ultrasonic irradiation position and ultrasonic irradiation angle.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[INDUSTRIAL FIELD OF APPLICATION]

The resent invention relates to the automatic analyzer which uses reagent or the like to analyze the components of the specimen as objects of analysis, and particularly to the automatic analyzer provided with an agitator to ensure that reagent required for analysis of specimen components is mixed with the specimen.

[0002]

[PRIOR ART]

To mix reagent with the specimen in the agitator of the conventional automatic analyzer, an agitating rod 61 having a spatula-shaped tip is inserted into the reaction bath where reagent is mixed with the specimen, and the agitating rod is rotated or moved in reciprocating motion.

[0003]

For example, the agitating rod 61 having a

spatula-shaped tip is inserted into the reaction vessel 11 containing a mixture of reagent and specimen as shown in Fig. 9 (a), and the agitating rod 61 is rotated by an actuator 60. Or the agitating rod 61 having a spatula-shaped tip is inserted into the reaction vessel 11 containing a mixture of reagent and specimen as shown in Fig. 9 (b), and the agitating rod 61 is moved in reciprocating motion by an actuator 60.

[0004]

When this conventional automatic analyzer is used, a trace amount of chemicals or specimens deposited on the agitating rod will cause a phenomenon called carry-over which affects the result of the next analysis. This requires some means to clean the agitating rod.

[0005]

Official Gazette of Japanese Patent Laid-Open NO.311204/1997 discloses an example of using a piezoelectric element as dispensing nozzle cleaning means. The cleaning means disclosed in this Journal gives mechanical oscillation to the nozzle itself to remove reagent or specimen deposited on the dispensing nozzle. It uses oscillation of the piezoelectric element to improve nozzle cleaning effect. This is not effective as an agitating means to promote mixing

between reagent and specimen.

[0006]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

To reduce physical loads of the specimen provider or to cut down system running costs for the automatic analyzer, efforts are made to reduce the amount of the specimen and reagent required for analysis of each item.

[0007]

In this case, if the amount of the specimen and reagent is reduced in the reaction vessel having the same capacity as that of the conventional reaction vessel as shown in Fig. 10(b), the area which light to be measured passes by will be smaller than when the amount of the specimen and reagent shown in Fig. 10(a) is not reduce. This will result in reduced measuring accuracy.

[0008]

To get an accurate measurement of the reduced amount of the specimen and reagent, it is necessary to reduce the capacity of the reaction vessel and to secure the liquid level of the specimen and reagent and light transmission area, as shown in Fig. 10 (c).

[0009]

However, physical motion for agitation such as

insertion of the agitating rod, rotation, etc. will become difficult due to reduced capacity of the reaction vessel in case of the automatic analyzer using the reaction vessel having a reduced capacity, where the agitating rod having a spatula-shaped tip in the agitator to mix the reagent with the specimen is inserted into said reaction vessel to rotate the agitating rod or move it in reciprocating motion.

[0010]

Furthermore, even if the agitating rod is cleaned, it is impossible to completely eliminate the phenomenon of carry-over where a trace amount of specimen or reagent is carried over to the next analysis. It is also impossible to eliminate the possibility of water for cleaning being brought into the reaction vessel by the agitating rod.

[0011]

Said carry-over and transfer of cleaning water into the vessel will have some adverse effect on the result of analysis when the capacity of the reaction vessel is reduced and the quality of reagent and specimen is decreased.

[0012]

The object of the present invention is to provide an automatic analyzer which is capable of effective

agitation of the reagent and specimen despite a small capacity of the reaction vessel without carry-over between specimens or water brought into the next process, thereby ensuring highly reliable results of analysis.

[0013]

[MEANS OF ATTAINING THE OBJECT]

The above object can be attained by the present invention which is configured as described below:

(1) An automatic analyzer comprises the following:

<1> an analyzer unit to analyze the components of a specimen to be analyzed,

<2> a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

<3> a controller to administer and control the entire system including said analyzer unit,

<4> an agitator installed on the side of the reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave and a reflecting means to reflect ultrasonic wave from said

ultrasonic generators and to irradiate lower ultrasonic wave toward the liquid level of liquid mixture from the bottom of said reaction vessel, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure by coordination between said lateral ultrasonic wave and lower ultrasonic wave, and

<5> an ultrasonic generator drive circuit to supply drive power to said ultrasonic generator.

[0014]

(2) An automatic analyzer comprises the following:

<1> an analyzer unit to analyze the components of a specimen to be analyzed,

<2> a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

wherein the bottom is inclined with respect to said liquid mixture level to serve as an ultrasonic wave reflecting means,

<3> a controller to administer and control the entire system including said analyzer unit,

<4> an agitator installed on the side of the

reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure by coordination between lower ultrasonic wave and said lateral ultrasonic wave;

wherein said lower ultrasonic wave is generated when ultrasonic wave generated from said ultrasonic generator is reflected against the bottom of said heat insulating bath, and said lower ultrasonic wave is irradiated from the bottom of said reaction vessel toward the liquid mixture level, and

<5> an ultrasonic generator drive circuit to supply drive power to said ultrasonic generator.

[0015]

(3) An automatic analyzer comprises the following:

<1> an analyzer unit to analyze the components of a specimen to be analyzed,

<2> a reaction vessel storing the specimen for analysis and liquid mixture with reagent or the like, wherein the bottom is inclined with respect to said liquid mixture level to serve as an ultrasonic wave

reflecting means,

<3> a heat insulating bath to support a reaction vessel and to hold the heat insulating medium to keep a constant temperature of liquid mixture between said specimen for analysis stored in said reaction vessel and reagent or others,

<4> a controller to administer and control the entire system including said analyzer unit,

<5> an agitator installed on the side of the reaction vessel supported by said heat insulating bath, wherein

said agitator comprises multiple ultrasonic generators to generate lateral ultrasonic wave, and

said agitator mixes and agitates the specimen in the reaction vessel, reagent or the like using the swirling flow generated by acoustic radiation pressure by coordination between lower ultrasonic wave and said lateral ultrasonic wave;

wherein said lower ultrasonic wave is generated when ultrasonic wave generated from said ultrasonic generator is reflected against the bottom of said reaction vessel, and said lower ultrasonic wave is irradiated toward the liquid level of said liquid mixture stored in said reaction vessel, and

<6> an ultrasonic generator drive circuit to

supply drive power to said ultrasonic generator.

[0016]

(4) An automatic analyzer described in above (1), (2) and (3) preferably characterized in that the material of said ultrasonic wave reflecting means has acoustic impedance different from that of the heat insulating medium in the heat insulating bath which transmits ultrasonic wave generated from the ultrasonic generator.

[0017]

(5) An automatic analyzer in above (1) and (2) characterized in that said ultrasonic wave reflecting means has a mechanism to change the ultrasonic irradiation position and ultrasonic irradiation angle.

[0018]

The ultrasonic generator is actuated, and the lower ultrasonic wave reflected by the ultrasonic wave reflecting means advances along the wall surface of the reaction vessel to collide with the liquid level of liquid mixture, thereby causing part of the liquid level to be raised. Lateral ultrasonic wave is applied to this portion. This allows lateral ultrasonic wave to reach the inclined portion of the raised liquid level of liquid mixture. Then swirling flow by agitation is produced by acoustic radiation pressure

of ultrasonic wave, where said flow has the liquid level as a starting point. The specimen and reagent are mixed and agitated by said swirling flow by agitation.

[0019]

[DESCRIPTION OF THE PREFERRED EMBODIMENTS]

The following describes the details of the embodiments of the present invention with reference to the drawings.

(First Embodiment)

Using Figs. 1 to 4, the following describes the first embodiment of the automatic analyzer according to the present invention:

Fig. 1 is a schematic cross sectional view representing a part of the automatic analyzer according to the present invention. Fig. 2 is a partial plan representing the analyzer of Fig. 1. Fig. 3 is a schematic cross sectional view representing of the major portion related to the first embodiment according to the present invention.

[0020]

Controller 1 in Figs. 1 and 2 comprises an information processing system or sequencer provided with a CPU, memory and I/O. Using the automatic analysis and diagnosis program and data stored in the

memory, said controller processes or administers and controls the operation of the automatic analyzer 5 and information required for analysis operation through the CPU.

[0021]

Detector 21 comprises a reaction vessel 11 to mix between reagent and specimen, a light emitting unit 15 to generate light 4 to be applied to said reaction vessel 11, and a light receiving unit 16 to detect the changes in the state of the specimen and reagent in the reaction vessel 11 in terms of absorbance. The illumination level detected by the light receiving unit 16 is sent as data to the controller 1 where it is processed.

[0022]

The agitator 22 mixes and agitates the specimen sent to the reaction vessel 11 from the specimen vessel 23 by the specimen dispensing pump 25 through the specimen dispensing probe 27, and the reagent sent to the reaction vessel 11 from the reagent vessel 24 by the reagent dispensing pump 26 through the reagent dispensing probe 28. In this process, said agitator uses swirling flow by agitation 36 (shown in Fig. 3) caused by ultrasonic waves generated from the ultrasonic generator 7.

[0023]

Reaction vessels 11 located at the agitator 22 and detector 21 are immersed in the heat insulating medium 13 represented by water in the circular heat insulating bath 12, and are kept at a constant temperature.

[0024]

Cleaner 20 consists of a reaction vessel cleaning nozzle 30 to discharge water to clear the reaction vessel 11 and to suck the water used for cleaning and waste water, and a reaction vessel cleaning pump 29.

[0025]

The multiple reaction vessel 11 is mounted on the reaction disk 1, and the reaction disk rotating shaft 18 is connected to the reaction disk motor 19. The reaction disk motor 19 is controlled by the controller 1, thereby causing rotating or movement together with the reaction disk 17, and traveling through agitator 22, detector 21 and cleaner 20.

[0026]

The ultrasonic element drive circuit 6 is a circuit used for the piezoelectric element 35 (given in Fig. 3) to generate the frequency and voltage produced by ultrasonic wave and to apply the voltage to the piezoelectric element 35. It is controlled by

the controller 1, and serves to oscillate the piezoelectric element 35 and to generate ultrasonic waves.

[0027]

The following describes the structure and operation of the agitator 22 in details:

When the specimen as a mixture of the specimen and reagent are to be mixed and agitated sufficiently as required for analysis in the reaction vessel 11 located in the agitator 22, the lower acoustic wave 8 and lateral ultrasonic wave 9a shown in Fig. 3 are controlled according to the sequence shown in Fig. 4, thereby producing swirling flow by agitation 36.

[0028]

Piezoelectric element for lateral irradiation 35 at the position where lateral ultrasonic wave 9a and lateral ultrasonic wave 9b on the lower side are produced is laid out to ensure that irradiation position can be changed in conformance to the amount of specimen in reaction vessel 11.

[0029]

Namely, multiple piezoelectric elements 35 (ultrasonic generators) are arranged in a row along the height of liquid level in the reaction vessel 11, or the electrode of one piezoelectric element is split

into multiple segments, which are formed in an array along the height of liquid level in the reaction vessel 11.

[0030]

The piezoelectric element for lateral irradiation 35 at the position where the lateral ultrasonic wave 9b on the lower side is generated is actuated, and the piezoelectric element for lateral irradiation 35 at the liquid level position is actuated in conformance to a particular situation, namely, in conformance to liquid level in the reaction vessel 11.

[0031]

An ultrasonic reflecting material 38 is installed through support/positioning mechanism 39 on the bottom of the portion of the heat insulating bath 12 where heat insulating medium 13 is stored.

[0032]

According to the operation sequence of the piezoelectric element for lateral irradiation 35, lateral ultrasonic wave 9b on the lower side is generated by actuation of the piezoelectric element for lateral irradiation 35 located at the bottom in Figs. 3 and 4 (piezoelectric element for lateral irradiation 35 at the position where lateral ultrasonic wave 9b on the lower side is generated).

[0033]

As shown in Fig. 4, said lateral ultrasonic wave 9b is gradually increased from 0 level to the level of maximum ultrasonic strength applied to lower position 44 during the voltage application period for lower element transition 46.

[0034]

Lateral ultrasonic wave 9b is reflected by the ultrasonic reflecting material 38 on the forward position, and its direction is changed to upward direction. Having been changed into lower ultrasonic wave 8, it enters the bottom of reaction vessel 11, and advances in the specimen along the wall surface close to the ultrasonic element 35 of the reaction vessel 11 to collide with the liquid level in the specimen. Then part of the specimen liquid level is raised by acoustic radiation pressure of ultrasonic wave.

[0035]

Then lateral ultrasonic wave 9a is applied to the raised potion of the specimen in the reaction vessel 11 by acoustic radiation pressure. Namely, after the lateral ultrasonic wave 9b has the maximum application intensity 44, lateral ultrasonic wave 9a is applied to the raised portion of the specimen at the ultrasonic

strength applied to lateral position 43 on the specimen liquid level, as shown in broken line 43 of Fig. 4.

[0036]

Then lateral ultrasonic wave 9a reaches the inclined part of the raised portion of the specimen through coordination with the lateral ultrasonic wave 9a and lateral ultrasonic wave 9b. Swirling flow by agitation 36, with specimen liquid level as a starting point, is produced by the acoustic radiation pressure of the ultrasonic wave. The specimen and reagent are mixed and agitated by said swirling flow by agitation 36.

[0037]

According to the Embodiment of the present invention, multiple ultrasonic elements are arranged along the direction of the liquid level on the side of the reaction vessel 11 containing the specimen. Ultrasonic wave generated from the ultrasonic generating elements located on the lower side is reflected by ultrasonic reflecting mechanism 10, thereby raising the specimen liquid level. After that, ultrasonic wave is irradiated to said raised portion from the side of the reaction vessel 11 to agitate the specimen.

[0038]

Thus, this method according to the present invention provides an automatic analyzer capable of ensuring an effective agitation of the reagent and specimen, hence, highly reliable results of analysis, despite the simple configuration and small size of the reaction vessel, without carry-over among specimens or water brought into the next process of analysis.

[0039]

The ultrasonic reflecting material 38 of the ultrasonic reflecting mechanism 10 which changes the direction by reflecting the lateral ultrasonic wave 9b uses the substance having the acoustic impedance different from that of the heat insulating medium 13 which ensures that the ultrasonic wave generated from the piezoelectric element is transmitted to the reaction vessel 11. Generally, it is effective in using such substances as glass and SUS having the acoustic impedance greater than that of the heat insulating medium 13 which transmits the ultrasonic wave.

[0040]

In the first Embodiment according to the present invention, agitators 22 are installed at one position. They can also be installed in multiple positions

according to the reaction speed of the reagent.

[0041]

(Second Embodiment)

Fig. 5 is a schematic cross sectional view representing the major portion of the second Embodiment of the automatic analyzer according to the present invention. The portions other than the configuration shown in Fig. 5 are the same as those shown in the first Embodiment, so they will not be illustrated or described.

[0042]

In this second Embodiment given in Fig. 5, the bottom of the position corresponding to the agitator 22 is designed in an inclined structure, wherein said bottom is placed face to face with the bottom 8 of the reaction vessel 11 of the heat insulating bath 12. The ultrasonic reflecting mechanism 10 is designed to ensure that the lateral ultrasonic wave 9b generated by the piezoelectric element 35 is reflected to proceed along the side wall (side wall close to piezoelectric element 35) of this reaction vessel 11 from the bottom of the reaction vessel 8. This allows the lateral ultrasonic wave 9b to proceed in the upward direction so that it can be used as the lower ultrasonic wave 8.

[0043]

The ultrasonic wave generation actuation sequence is configured to actuate the piezoelectric element for lateral irradiation 35 located at the bottom and to generate the lateral ultrasonic wave 9b. Lateral ultrasonic wave 9b is reflected by the ultrasonic reflecting material 38 on the forward position so that it proceeds upward. As a lower ultrasonic wave 8, it enters the bottom of the reaction vessel 11. The lower ultrasonic wave 8 proceeds in the specimen to collide with the specimen liquid level, and the specimen liquid level is raised by the acoustic radiation pressure of ultrasonic wave.

[0044]

Then lateral ultrasonic wave 9a reaches the inclined portion of the liquid level raised by application of lateral ultrasonic wave 9a to the raised portion of the specimen in the reaction vessel. Swirling flow by agitation 36 with the specimen liquid level as a starting point is produced by the acoustic radiation pressure of ultrasonic wave. The specimen and reagent are mixed and agitated by the swirling flow by agitation 36.

[0045]

As described above, according to the second

Embodiment of the present invention, the same effect as that of the first Embodiment can be obtained.

[0046]

According to the second Embodiment of the present invention, if the bottom is designed in an inclined structure over the entire circumference of the heat insulating bath 12, the flow channel area of the heat insulating medium 13 circulating in the heat insulating bath 12 can be made almost the same over the entire circumference of the heat insulating bath 12. This ensures that the flow velocity of the heat insulating medium 13 is constant to minimize the changes in the temperature of the specimen in the reaction vessel 11. This makes it possible to get more stable measurement data.

[0047]

(Third Embodiment)

Fig. 6 is a schematic cross sectional view representing the major part of the automatic analyzer according to the third Embodiment of the present invention. The portions other than the configuration shown in Fig. 6 are the same as those shown in the first Embodiment, so they will not be illustrated or described.

[0048]

The bottom inside the reaction vessel 11 of the automatic analyzer in Fig. 6 is designed in an inclined structure to create the mechanism which ensures that lateral ultrasonic wave 9b generated by the piezoelectric element 35 is reflected to proceed to the liquid level from the bottom of the reaction vessel 11. This allows the lateral ultrasonic wave 9b to proceed upward; thus, it can be used as lower ultrasonic wave 8.

[0049]

The sequence to actuate ultrasonic wave generation actuates the piezoelectric element for lateral irradiation 35 located at the bottom to generate lateral ultrasonic wave 9b. Lateral ultrasonic wave 9b enters the reaction vessel 11 from the side, and is reflected by the inclined structure of the bottom of the reaction vessel 11. Then it proceeds upward to advance through the specimen as lower ultrasonic wave 8. Then lower ultrasonic wave 8 collides with the specimen liquid level, and part of the specimen liquid level is raised by the acoustic radiation pressure of ultrasonic wave.

[0050]

Then lateral ultrasonic wave 9a is applied to the raised portion of the specimen in the reaction vessel

11. Lateral ultrasonic wave 9a reaches the inclined portion of the raised liquid level, and swirling flow by agitation 36 with the specimen liquid level as a starting is produced by the acoustic radiation pressure of ultrasonic wave. The specimen and reagent are mixed and agitated by said swirling flow by agitation 36.

[0051]

The same effect as that of the first Embodiment cab be obtained according to the third Embodiment of the present invention.

[0052]

In contrast to the first and second Embodiments, the third Embodiment of the present invention does not require installation of any structure in the heat insulating bath 12. This provides the effect of simplifying the structure of the heat insulating bath 12 and reducing the manufacturing cost.

[0053]

The material of the reaction vessel 11 may be plastic, but is preferred to be glass.

[0054]

(Fourth Embodiment)

Fig. 7 is a schematic cross sectional view representing the major part of the automatic analyzer

according to the fourth Embodiment of the present invention. The portions other than the configuration shown in Fig. 7 are the same as those shown in the first Embodiment, so they will not be illustrated or described.

[0055]

This fourth Embodiment shows an example of allowing change of the position of the ultrasonic reflecting mechanism 10 and the angle of the ultrasonic reflecting material 38 in the first and second Embodiments.

[0056]

In Fig. 7, the reflecting material support mechanism 39 is connected with the drive mechanism 52, and drive mechanism 52 is connected with the reflecting mechanism traveling actuator 51 exemplified by the motor ands solenoid. Said reflecting mechanism traveling actuator 51 is actuated by the command from the controller 1 through reflecting mechanism traveling control signal 54, thereby changing the position in the heat insulating bath 12 of the reflecting material support mechanism 39.

[0057]

The reflecting material 38 is connected to the reflecting material traveling actuator 50 exemplified

by the piezoelectric element. Said reflecting material traveling actuator 50 is actuated upon receipt of a command from the controller 1 through the reflecting material angle control signal 53, and changes the angle of the reflecting material 38. Namely, the controller 1 changes the position of applying lower ultrasonic wave 8 and the angle of application in conformance to the amount of the specimen in the reaction vessel 11 and the material, size and shape of the reaction vessel 11. This makes it possible to correct the disposition for coordination between the lower ultrasonic wave and lateral ultrasonic wave on the specimen liquid level caused by the mechanical error of each system (deviation of the positions for application of the lower ultrasonic wave and lateral ultrasonic wave to generate swirling flow by agitation by coordination between lower ultrasonic wave and lateral ultrasonic wave).

The same effect as that of the first Embodiment cab be obtained according to the fourth Embodiment of the present invention.

[0058]

The fourth Embodiment of the present invention makes it possible to change the position of applying lower ultrasonic wave 8 and the angle of application

in conformance to the amount of specimen in the reaction vessel 11 and the material, size and shape of the reaction vessel 11. This makes it possible to correct the disposition for coordination between the lower ultrasonic wave and lateral ultrasonic wave on the specimen liquid level caused by the mechanical error of each system.

[0059]

In the above-mentioned Embodiments of the present invention, ultrasonic wave generated from piezoelectric element 35 arranged toward the side wall in the reaction vessel 11 is reflected by the reflection board to generate lower ultrasonic wave. Instead of using a reflection board, it is also possible to lay out the piezoelectric element for generation of special-purpose lower ultrasonic wave at the position face to face with the bottom surface of reaction vessel 11, separately from the piezoelectric element to generate lateral ultrasonic wave. However, such configuration leads to complicated configuration as compared with the above-mentioned Embodiments according to the present invention.

[0060]

Namely, the piezoelectric element for lateral irradiation 35 to apply ultrasonic wave from the side

of the reaction vessel 11 and the lower irradiation piezoelectric element 37 to apply ultrasonic wave from the bottom of the reaction vessel 11 are laid out, as shown in Fig. 8. Then the lower irradiation piezoelectric element 37 is actuated, and lower ultrasonic wave 8 is applied toward the liquid level of the specimen and reagent from the lower side of the reaction vessel 11 containing specimen and reagent. Part of the liquid level is raised by the acoustic radiation pressure of lower ultrasonic wave 8 to actuate piezoelectric element for lateral irradiation 35 and to generate lateral ultrasonic wave 9a, which is applied to the raised portion of the liquid level. Such configuration is also possible.

[0061]

However, the configuration shown in Fig. 8 requires the agitation mechanism at one position to have both the piezoelectric element for lateral irradiation 35 and lower irradiation piezoelectric element 37. This will lead to complicated configuration and increased number of components.

[0062]

Thus, the Embodiments of the present invention provide an automatic analyzer capable of ensuring an effective agitation of the reagent and specimen, hence,

highly reliable results of analysis, despite the simple configuration and small size of the reaction vessel, without carry-over among specimens or water brought into the next process of analysis.

[0063]

In the embodiment shown in Fig. 5, it is possible to lay out the means which change the angle of inclination of the bottom of heat insulating bath 12.

[0064]

[EFFECTS OF THE INVENTION]

The present invention provides an automatic analyzer capable of ensuring an effective agitation of the reagent and specimen, hence, highly reliable results of analysis, despite the simple configuration and small size of the reaction vessel, without carry-over among specimens or water brought into the next process of analysis.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a schematic block diagram representing the first embodiment of the automatic analyzer according to the present invention;

Fig. 2 is a partial plan representing the analyzer of Fig. 1;

Fig. 3 is a schematic cross sectional view representing of the major portion related to the first

embodiment according to the present invention;

Fig. 4 is time chart showing the operation of the ultrasonic agitator;

Fig. 5 is a schematic cross sectional view representing the major portion of the second embodiment according to the present invention;

Fig. 6 is a schematic cross sectional view representing the major portion of the third embodiment according to the present invention;

Fig. 7 is a schematic cross sectional view representing the major portion of the fourth embodiment according to the present invention;

Fig. 8 is a schematic cross sectional view representing the comparative examples describing the effects of the present invention;

Fig. 9 is a drawing representing an example of the automatic analyzer in the prior art; and

Fig. 10 is a drawing describing the problems raised by reduction in the amount of liquid and in the capacity of the reaction vessel.

[DESCRIPTION OF NUMERALS]

1. Controller

2. Power supply

3. Commercial power supply

4. Light

5. Automatic analyzer

6. Ultrasonic element drive circuit

7. Ultrasonic generator

8. Lower ultrasonic wave

9a. Lateral ultrasonic wave 1

9b. Lateral ultrasonic wave 2

10. Ultrasonic reflecting mechanism

11. Reaction vessel

12. Heat insulating bath

13. Heat insulating medium

14. Specimen

15. Light emitting unit

16. Light receiving unit

17. Reaction disk

18. Reaction disk rotating shaft

19. Reaction disk rotating motor

20. Cleaner

21. Detector

22. Agitator

23. Specimen vessel

24. Reagent vessel

25. Specimen dispensing pump

26. Reagent dispensing pump

27. Specimen dispensing probe

28. Reagent dispensing probe

29. Reaction cell cleaning pump

30. Reaction cell cleaning nozzle

31. Cleaner control signal

32. Specimen and reagent dispensing pump control signal

33. Piezo drive circuit control signal

34. Piezo drive power line

35. Piezoelectric element for lateral irradiation

36. Swirling flow by agitation

38. Ultrasonic reflecting material

39. Support/positioning mechanism

40. Time axis

41. Axis for ultrasonic strength applied

42. Ultrasonic strength applied to lower position

43. Ultrasonic strength applied to lateral position

44. Maximum ultrasonic strength applied to lower position

45. Maximum ultrasonic strength applied to lateral position

46. Voltage application period for lower element transition

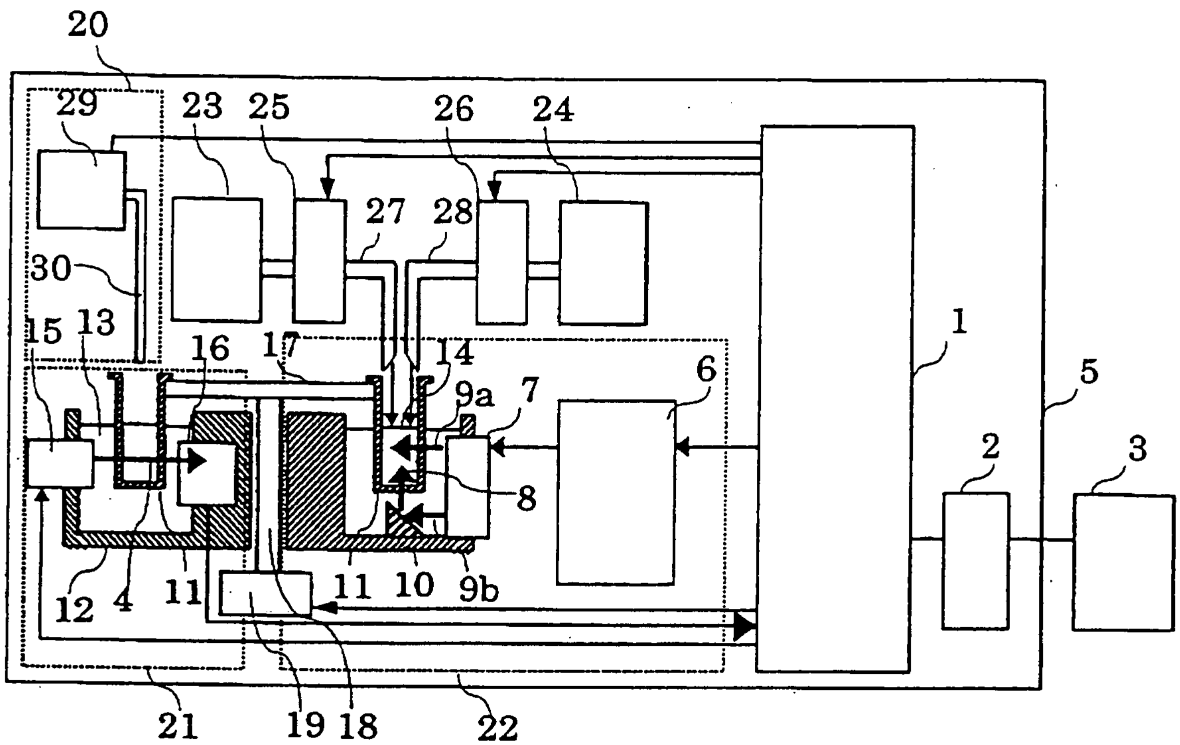
47. Constant voltage application period for lower element

48. Voltage application period for lateral element

50. Reflecting material traveling actuator
51. Reflecting mechanism traveling actuator
52. Drive mechanism
53. Reflecting material angle control signal
54. Reflecting mechanism traveling control signal

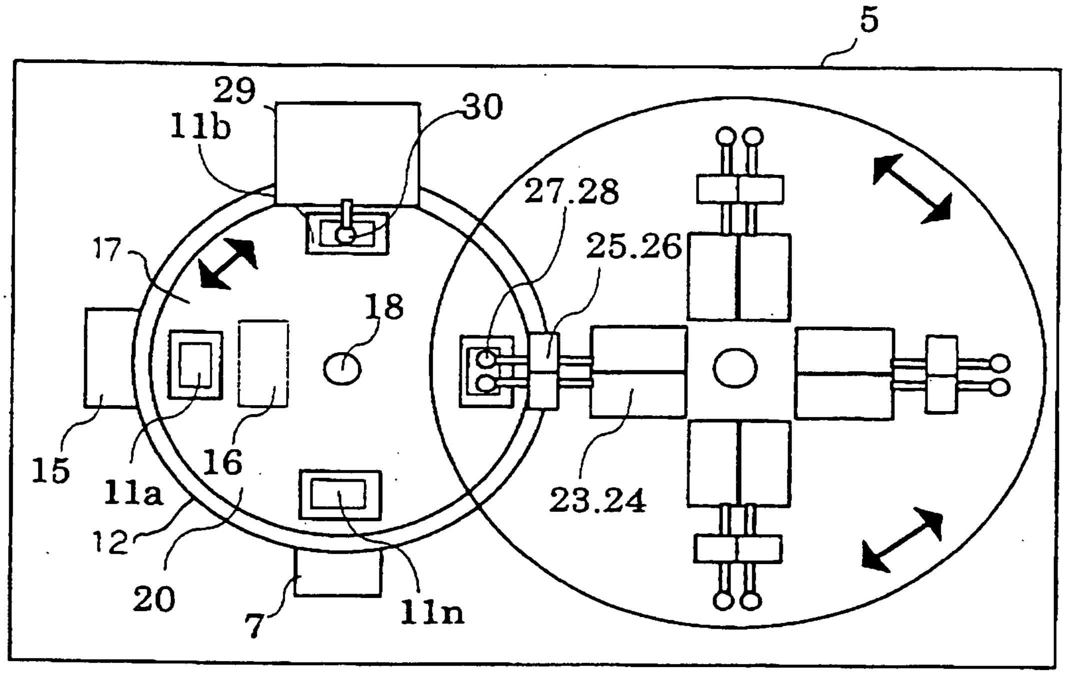
【書類名】　　　　図面　(DOCUMENTS NAME) DRAWINGS

【図１】(Fig. 1)

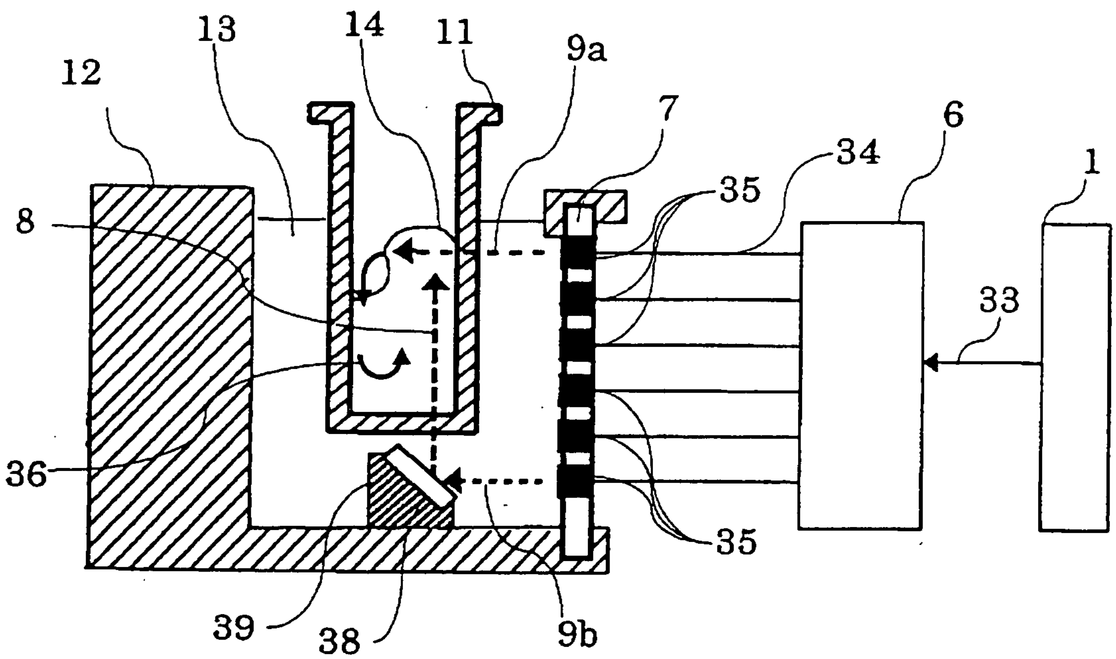


1.Controller
2.power supply
3.Commercial power supply
4.Light
5.Automatic analyzer
6.Ultrasonic element drive circuit
7.Ultrasonic generator
8.Lower ultrasonic wave
9a.Lateral ultrasonic wave 1
9b.Lateral ultrasonic wave 2
10.Ultrasonic reflecting mechanism
11.Reaction vessel
12.Heat insulating bath
13.Heat insulating medium
14.Specimen
15.Light emitting unit
16.Light receiving unit
17.Reaction disk
18.Reaction disk rotating shaft
19.Reaction disk rotating motor
20.Cleaner
21.Detector
22.Agitator
23.Specimen vessel
24.Reagent vessel
25.Specimen dispensing pump
26.Reagent dispensing pump
27.Specimen dispensing probe
28.Reagent dispensing probe
29.Reaction cell cleaning pump
30.Reaction cell cleaning nozzle
31.Cleaner control signal
32.Specimen and reagent dispensing pump control signal

【図２】(Fig. 2)



【図3】(Fig. 3)



33. Piezo drive circuit control signal

34. Piezo drive power line

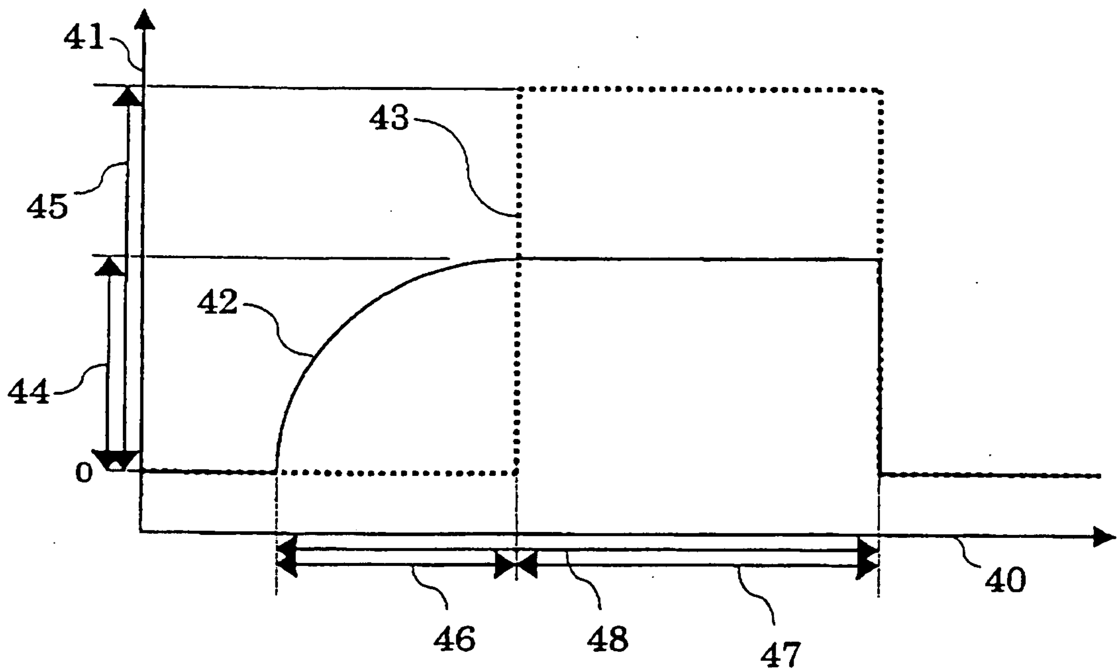
35. Piezoelectric element for lateral irradiation

36. Swirling flow by agitation

38. Ultrasonic reflecting material

39. Support/positioning mechanism

【図4】(Fig. 4)



40. Time axis

41. Axis for ultrasonic strength applied

42. Ultrasonic strength applied to lower position

43. Ultrasonic strength applied to lateral position

44. Maximum ultrasonic strength applied to lower position

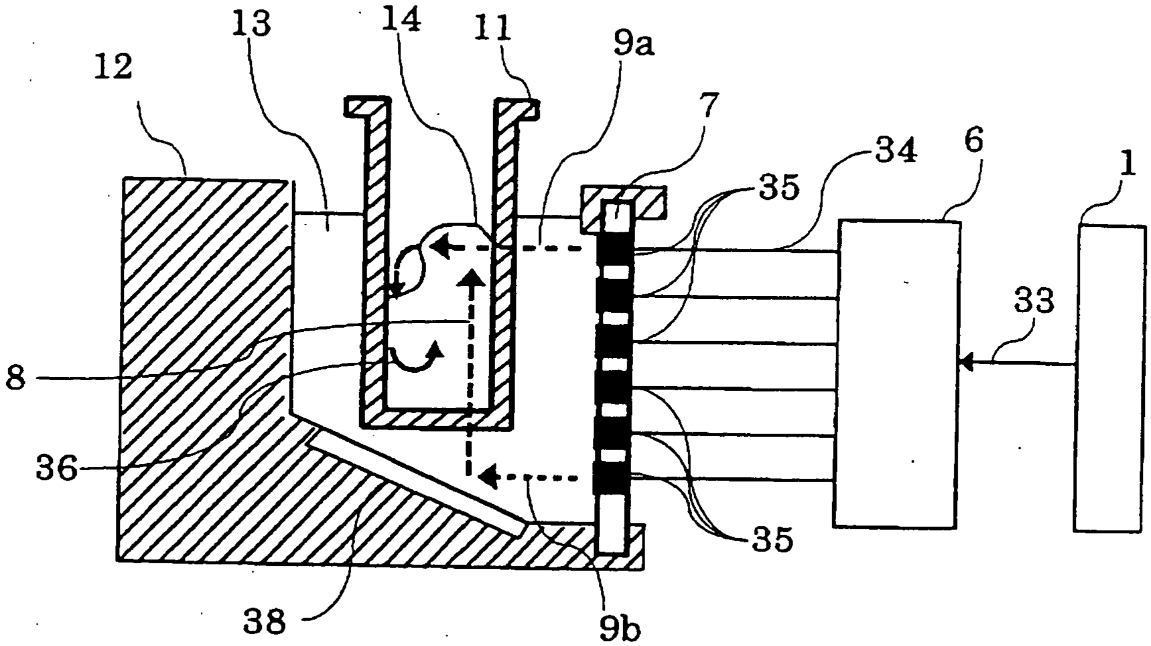
45. Maximum ultrasonic strength applied to lateral position

46. Voltage application period for lower element transition

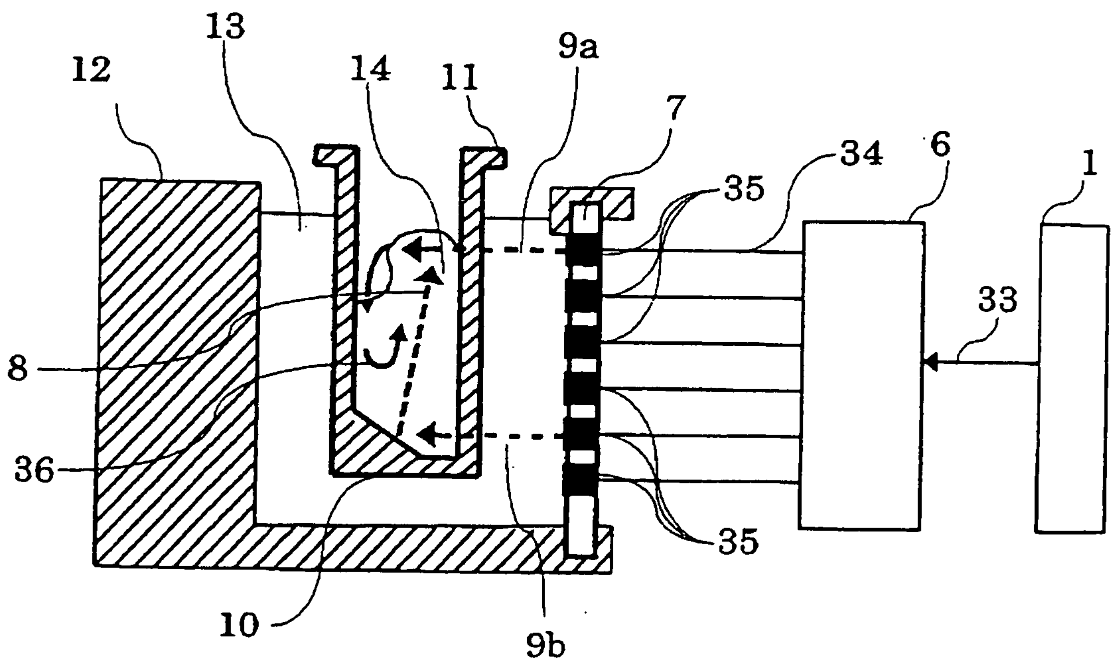
47. Constant voltage application period for lower element

48. Voltage application period for lateral element

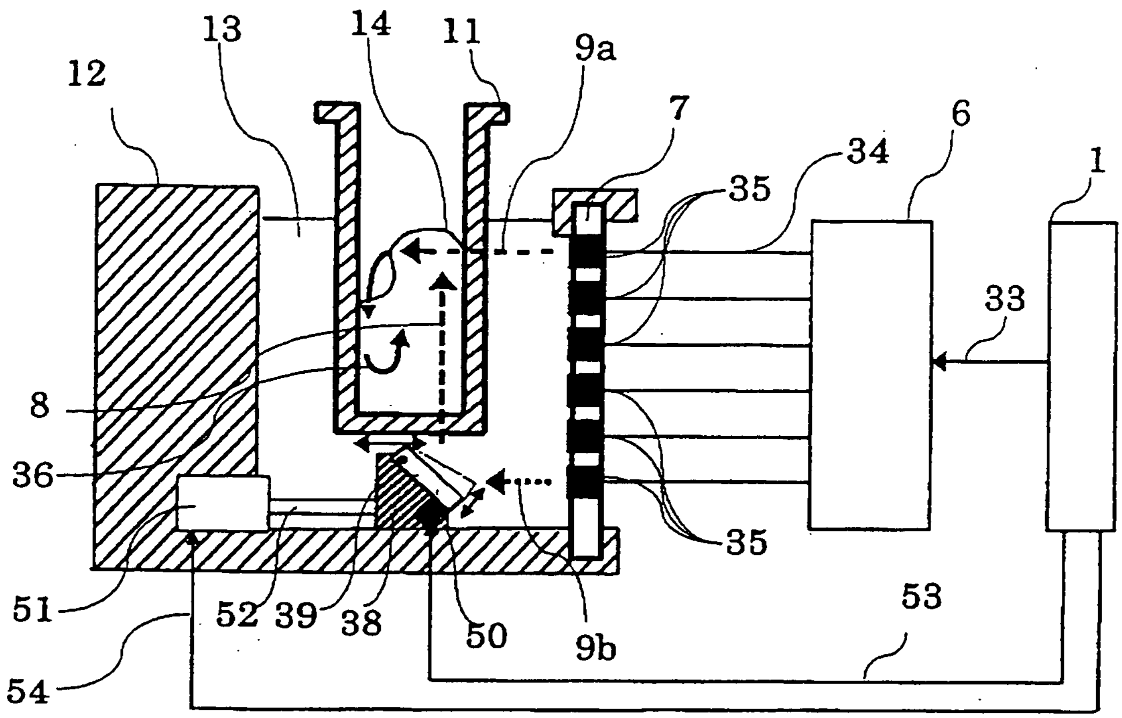
【図５】(Fig. 5)



【図６】(Fig. 6)



【図7】(Fig. 7)



50. Reflecting material traveling actuator

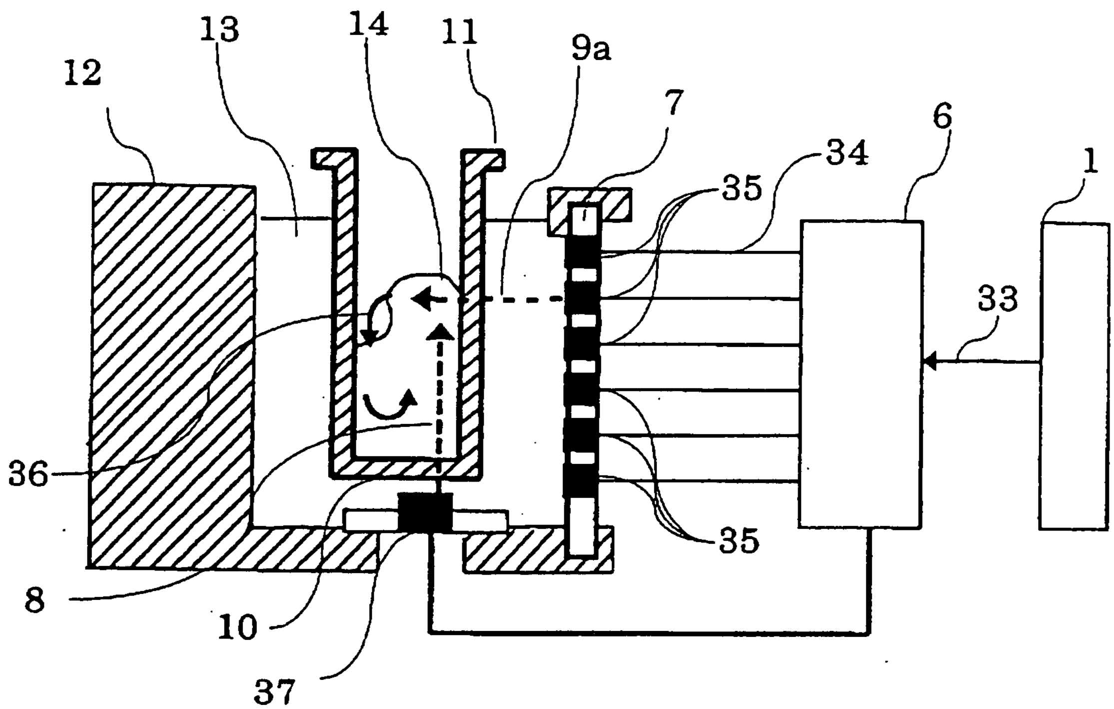
51. Reflecting mechanism traveling actuator

52. Drive mechanism

53. Reflecting material angle control signal

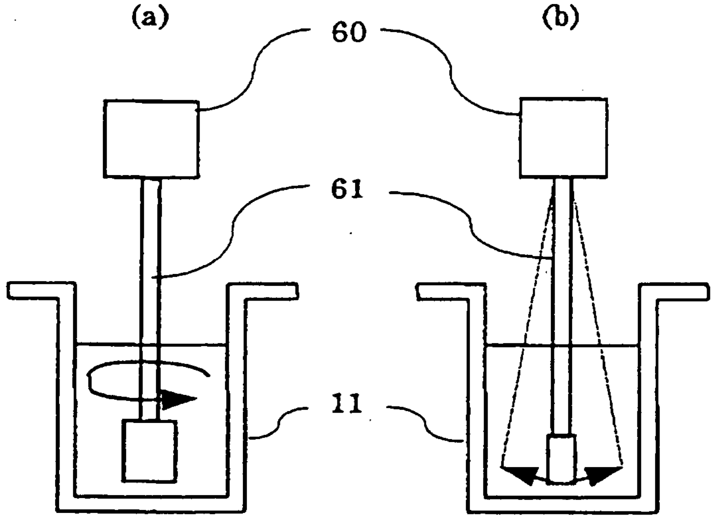
54. Reflecting mechanism traveling control signal

【図8】(Fig. 8)



37. Lower irradiation piezoelectric element

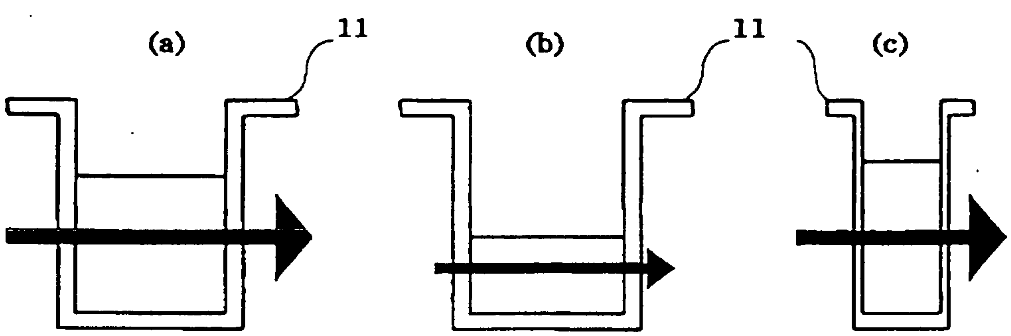
【図９】(Fig. 9)



60. Actuator

61. Agitating rod

【図１０】(Fig.10)



[ABSTRACT]

[OBJECT]

The object of the present invention is to provide an automatic analyzer capable of ensuring an effective agitation of the reagent and specimen, hence, highly reliable results of analysis, despite small size of the reaction vessel, without carry-over among different specimens.

[MEANS OF ATTAINING THE OBJECT]

The above object can be attained by the present invention providing an air heater characterized as follows: Multiple piezoelectric elements 35 are arranged in a row along the height of liquid level in the reaction vessel 11, and an ultrasonic reflecting material 38 is installed on the bottom of the portion of the heat insulating bath 12 where heat insulating medium 13 is stored. Lateral ultrasonic wave 9b on the lower side is generated by actuation of the piezoelectric element for lateral irradiation 35 located at the bottom. Lateral ultrasonic wave 9b is reflected by the ultrasonic reflecting material 38, and, as lower ultrasonic wave 8, advances along the wall surface of the reaction vessel to collide with the specimen liquid level, thereby causing part of the liquid level to be raised. When lateral ultrasonic

wave 9a is applied to this portion, lateral ultrasonic wave 9a reaches the inclined portion of the raised liquid level of the specimen. Swirling flow by agitation 36, with specimen liquid level as a starting point, is produced by the acoustic radiation pressure of the ultrasonic wave. The specimen and reagent are mixed and agitated by said swirling flow by agitation 36.

[SELECTED DRAWING] Fig. 3

CERTIFICATE OF TRANSLATION

I, Akio Matsuzawa, of 2582-37, Migawa-cho, Mito-shi, Ibaraki 310-0913, Japan, hereby state that I am familiar with the Japanese and English languages. I further certify that the attached English translation of Japanese Patent Application JP 2000-50034 is an accurate translation in the English language.

Dated this 24th day of October, 2007

Akio Matsuzawa

Akio Matsuzawa

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[ID Code] 100087170

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[Indication of Fee]

[Registered No. for Advance Payment] 012014

[Amount of Payment] 21,000

[List of Attached Documents]

[Name of Document] Specification 1

[Name of Document] Drawing(s) 1

[Name of Document] Abstract 1

[Proof YES/NO] YES

[NAME OF DOCUMENT] SPECIFICATIONS

[TITLE OF THE INVENTION] AUTOMATIC ANALYZER

[WHAT IS CLAIMED]

1. An automatic analyzer provided with an analysis means to analyze the physical properties of a specimen where said specimen and reagent poured into a reaction vessel are to be analyzed,

said automatic analyzer comprising;

(1) an acoustic wave generation means installed outside said reaction vessel to irradiate acoustic wave toward said reaction vessel, and

(2) a control means to control the position for irradiation of acoustic wave by said acoustic wave generating means for each object to be analyzed and irradiation intensity.

2. An automatic analyzer according to Claim 1 further comprising a storage means to store the acoustic wave irradiation position in an associated format for each item,

wherein said control means refers to stored data in said storage means to determine the irradiation position in conformance to analysis item for objects to be analyzed.

3. An automatic analyzer according to Claim 1 further comprising a storage means to store the amount

of specimen and reagent required for each item in an associated format,

wherein said control means refers to stored data in said storage means to calculate the liquid level of the specimen and reagent inside the reaction vessel in conformance to analysis item for objects to be analyzed, and to determine the irradiation position according to the calculated liquid level.

4. An automatic analyzer according to Claim 1 further comprising a receiving means to receive the command on the position for irradiation of acoustic wave by said acoustic wave generating means,

wherein said control means determines the irradiation position according to the command received by said receiving means.

5. An automatic analyzer according to Claim 1 further comprising a storage means which stores the acoustic wave irradiation intensity in an associated format for each analysis item,

wherein said control means refers to stored data in said storage means to determine the irradiation intensity in conformance to analysis item for objects to be analyzed.

6. An automatic analyzer according to Claim 1 further comprising a storage means to store the

acoustic wave irradiation intensity in an associated format for each information on reagent,

wherein said control means refers to stored data in said storage means to determine the irradiation intensity in conformance to the reagent to be analyzed.

7. An automatic analyzer according to Claim 1 further comprising a reading means to read the information on acoustic wave irradiation intensity recorded in the reaction vessel containing the reagent before it is poured into said reaction vessel,

wherein said control means refers to the reading of said reading means to determine irradiation intensity in conformance to the reagent as an object to be analyzed.

8. An automatic analyzer according to Claim 1 further comprising a receiving means to receive the command on the intensity for irradiation of acoustic wave by said acoustic wave generating means,

wherein said control means determines the irradiation intensity according to the command received by said receiving means.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[INDUSTRIAL FIELD OF APPLICATION]

The present invention relates to an automatic

analyzer, and particularly to the step of agitation to mix the specimen and reagent poured into a vessel.

[0002]

[PRIOR ART]

One of the known conventional chemnical analyzers is the one designed to analyze the reaction solution obtained by mixing a desired reagent with such specimen as serum and making them react, wherein chemical analysis is provided by measuring its absorbance.

[0003]

The chemical analyzer of said type comprises a mechanism to pour the specimen and reagent into a reaction vessel, a mechanism to agitate the specimen and reagent in the reaction vessel and a mechanism to analyze physical properties of the specimen during or after reaction. Especially in the mechanism to agitate the specimen and reagent in the reaction vessel, a spatula, screw or the like is lowered below the liquid level in the reaction vessel,

and agitation is provided by driving of the motor connected to the base of the spatula, screw or the like, thereby ensuring uniform mixing between the specimen and reagent through rotation/vibration.

[0004]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

In the field of analyzers, a big technological issue is raised by a trace amount of the specimen and reagent. Namely, there is a decrease in the amount of specimens that can be assigned to a single item with the increase in the number of analysis items. Analysis of a trace amount of specimens conventionally regarded as an advanced level of analysis is carried out on a routine basis, including the DNA analysis where the specimens themselves are high-priced and cannot be prepared in great amounts. Furthermore, with the advance in the level of analysis, higher priced reagents have come to be used commonly. This requires decrease in the amount of reagents in terms of costs. Such decrease in the amount of specimens and reagents is required is one of the reasons for the encouragement of reduction in the size of the reaction vessel.

[0005]

According to the prior art, however, agitation of the specimens and reagents poured in the reaction vessel is performed mechanically by the spatula, screw or the like. Compared with reduction in the amount of specimens and reagents (reduction in the size of the reaction vessel), minitualization of the spatula,

screw or the like is currently very difficult.

[0006]

In the mechanical agitation with the conventional spatula, screw or the like, the agitated substances subsequent to agitation are deposited on spatula, screw, etc., and are taken out of the reaction vessel. Or water used to clean the spatula, screw or the like subsequent to agitation is deposited on the spatula, screw or the like and is brought into the reaction vessel. If only the reaction vessel is minimized as far as practicable with the size of the spatula, screw or the like left unchanged, there will be increase in the amount of the agitated substances to be removed, or water to be brought to the reaction vessel. This gives a serious impact on the result of analysis.

[0007]

To solve such a problem, a non-contact agitation means is invented. According to this method, acoustic wave is irradiated from outside the reaction vessel toward the reaction vessel, and agitation is carried out without touching the agitated substance inside the vessel. A certain amount of agitated substances was required in the mechanical agitation using the spatula, screw or the like. Use of the acoustic wave allows the agitated substances to agitate themselves. They can be

mixed sufficiently even with a small amount of substances to be agitated. This ensures that the amount required for analysis is sufficient as the amount of specimens and reagents, and makes it possible to minitualize the size of the reaction vessel.

[0008]

When using said non-contact agitating means, more effective agitation is ensured by giving consideration to the liquid levels of agitated substances in different reaction vessels, and kinetic characteristics of agitated substances such as viscosity, density and surface tension.

[0009]

The object of the present invention is to provide agitation by application of acoustic wave without contacting the specimen and reagent in the reaction vessel when analyzing the specimen and reagent poured into the reaction vessel in an automatic analyzer. At the same time, the present invention is intended to ensures an effective agitation for each object to be analyzed.

[0010]

[MEANS FOR SOLVING THE PROBLEMS]

To achieve said objective, the present invention

provides an automatic analyzer designed to analyze the specimen and reagent poured in the reaction vessel. This automatic analyzer comprises a means to analyze the physical properties of the specimen, an acoustic wave generating means installed outside a reaction vessel to apply acoustic wave toward said reaction vessel, and a control means to control the position to apply acoustic wave through said acoustic wave generating means and the irradiation intensity for each object to be analyzed.

[0011]

[DESCRIPTION OF THE PREFERRED EMBODIMENTS]

The following describes the embodiments according to the present invention with reference to drawings:

[0012]

Fig. 1 is a perspective view representing the configuration of an automatic analyzer related to the embodiments according to the present invention. Fig. 2 is a vertical cross sectional view around the agitating mechanism mounted on the automatic analyzer illustrated in Fig. 1.

[0013]

As shown in Fig. 1, the automatic analyzer according to the present Embodiment mainly comprises a specimen disk 1, a reagent disk 2, a reaction disk 3,

a reaction bath 4, a sampling mechanism 5, a pipetting mechanism 6, an agitating mechanism 7, a photometric mechanism 8, a cleaning mechanism 9, a display unit 10, an input unit 11, a storage unit 12 and a controller 13.

[0014]

In Fig. 1, multiple specimen vessels 16 with sampled specimens mounted therein are arranged at fixed positions on the circumferences of circular disk 17 of the specimen disk 1, and the circular disk 17 is driven in the circumstantial direction by the drive mechanism comprising a motor and rotating shaft (not illustrated), etc. so that said disk can be positioned.

[0015]

In Fig. 1, multiple reagent bottles 18 containing the reagent to cause reaction in a state mixed with the specimen are arranged at a fixed position on the circumference of the circular disk 19 of the reagent disk 2, and a temperature-controlled cold reserver 20 is provided around it. The circular disk 19 is driven in the circumstantial direction by the drive mechanism comprising a motor and rotating shaft (not illustrated), etc. so that said disk can be positioned.

[0016]

In Fig. 1, multiple reaction vessel holders 22

holding the reaction vessel 21 to contain specimen and reagent are installed on the reaction disk 3, and a step of circumferential rotation and stop is repeated at a specified cycle by a drive mechanism 23, thereby allowing intermittent transfer of the reaction vessel 21.

[0017]

In Fig. 1, the reaction bath 4 is installed along the travel path of the reaction vessel 21. It is a thermostatic bath to keep reaction solution in the reaction vessel 21 at a specified temperature in order to promote chemical reaction of the specimen and reagent by, for example, temperature controlled water. The reaction vessel 21 moves in the reaction tank 4.

[0018]

In Fig. 1, sampling mechanism 5 comprises a probe 24, an arm 26 mounted on the bearing shaft 25, and a drive mechanism to permit reciprocating motion between the specimen disk 1 and reaction disk 3 using the bearing shaft 25 as a center of rotation. In conformance to the predetermined sequence, the specimen in the specimen vessel 16 fed to a specified position through the rotation of the specimen disk 1 is supplied to the reaction vessel 21. Similarly, the pipetting mechanism 6 comprises a probe 27, an arm 29

mounted on the bearing shaft 28, and a drive mechanism to permit reciprocating motion between the specimen disk 2 and reaction disk 3 using the bearing shaft 28 as a center of rotation. In conformance to the predetermined sequence, the reagent in the reagent bottle 18 fed to a specified position through the rotation of the specimen disk 2 is supplied to the reaction vessel 21. In this case, specimen vessel 16 and reagent bottle 18 contain specimens and reagents of different types, and a required quantity is fed to the reaction vessel 21.

[0019]

In Fig. 1, an agitating mechanism 7 is a non-contact agitating mechanism to agitate and mix the specimen and reagent in the reaction vessel 21 by irradiation of acoustic wave from the side of the reaction vessel 21 fed to the position (position of agitation). It comprises (1) a stationary unit 32 fixed at the position where acoustic wave can be applied to the position of agitation from the side of the reaction vessel 21, (2) a piezoelectric element driver 14 to drive the piezoelectric element (30 in Fig. 2), and (3) agitating mechanism controller 15. Said agitating mechanism controller 15 is connected to controller 13 to drive piezoelectric element driver 14

and control the entire agitating mechanism 7.

[0020]

In agitating mechanism 7, piezoelectric element 30 as a sound source is installed on the stationary unit 31 in such a way that its one side is immersed in the temperature controlled water of the reaction bath 4, as shown in Fig. 2. Said piezoelectric element 30 comprises multiple electrodes 32. Oscillation is given at a specified frequency by piezoelectric element driver 14, and the position for irradiation of acoustic wave can be changed by the electrode 32 to be oscillated.

[0021]

In Fig. 2, reaction vessel 21 filled with the specimen and reagent is fixed to the reaction disk 3 by the reaction vessel holder 22. In conformance to rotation of the reaction disk 3 in the circumferential direction, it moves in a state immersed in the reaction bath 4 containing temperature controlled water. When it is shifted to the position of agitation and is stopped there, oscillation is given to piezoelectric element 30 at a specified frequency by piezoelectric element driver 14. Oscillation of the piezoelectric element 30 is transmitted as acoustic wave in the temperature controlled water of the

reaction bath 4 to reach the side of the reaction vessel 21. Said acoustic wave passes through the wall surface of the reaction vessel 21, and reaches the specimen and reagent as internal agitated substances. Transmitted oscillatory wave acts on the gas/liquid boundary of the agitated substances to cause swirling flow. This swirling flow promotes movement of the specimen, allowing the specimen and reagent to be agitated, without the need of inserting the spatula, screw or the like into the reaction vessel 21.

[0022]

To reinforce irradiation intensity, an acoustic lens can be installed in the direction of the oscillatory wave of the piezoelectric element 30. Said acoustic lens serves to condense oscillatory wave, and is effective especially when quick agitation is required.

[0023]

Going back to Fig. 1, the photometric mechanism 8 (not illustrated) comprises a light source, a photometer, a lens and a photometric signal processing unit. It measures the physical properties of the specimen by means of light; for example, it measure the absorbance of reaction solution in the reaction vessel 21. The cleaning mechanism 9 comprises multiple

nozzles 33 and its vertical drive mechanism 34. Reaction solution in the reaction vessel 21 is sucked and the cleaning solution is discharged. Then the reaction vessel 21 fed to that position (cleaning position) is cleaned.

[0024]

In Fig. 1, display unit 10 provides various screen displays including analysis items and results of analysis, and input unit 11 enters various types of information such as analysis items. Storage unit 12 stores the information on the predetermined sequence (program) to control each mechanism and analysis items.

[0025]

The automatic analyzer according to the present Embodiment comprises a syringe, a pump, etc. in addition to the above-mentioned components. They are all controlled by the controller 13 according to the sequence stored in the storage unit 12.

[0026]

The following describes the operation of the automatic analyzer configured as described above:

[0027]

When the reaction vessel 21 cleaned by the cleaning mechanism 9 is driven by the reaction disk 3 and is fed to the specimen supply position, the

specimen disk 1 rotates to feed the specimen vessel 16 containing the specimen to the sampling position. Similarly, the reagent disk 2 feeds the required reagent bottle 18 to the pipetting position.

[0028]

This is followed by the operation of the sampling mechanism 5. The probe 24 is used to pour the specimen into the reaction vessel 21 fed to the specimen supply position from the specimen vessel 16 fed to the sampling position. The reaction vessel 21 containing the specimen is fed to the reagent supply position, and reagent is poured into the reaction vessel 21 fed to the reagent supply position from the reagent bottle 18 fed to the pipetting position on the reagent disk 2 by the operation of the pipetting mechanism 6.

[0029]

After that, the reaction vessel 21 is fed to the position of agitation, and the specimen and reagent are agitated by means of the agitating mechanism 7.

[0030]

The absorbance of the reaction solution having been agitated is measured by the photometric mechanism 8 when the reaction vessel 21 passes through the light source and photometer. This measurement is carried out several cycles. The reaction vessel 21 which has been

measured is cleaned by the cleaning mechanism 9.

[0031]

When such a series of operations is carried out for each reaction vessel 21, analysis by the automatic analyzer according to the present Embodiment is performed.

[0032]

The following describes the characteristics of the embodiment with regard to agitation carried out by the agitating mechanism 7:

[0033]

In the present Embodiment, the agitating mechanism 7 completes the following two preparatory steps in conformance to the command of the controller 13 by the time when the reaction vessel 21 is fed to the position of agitation:

(1) Determine acoustic wave irradiation position.

(2) Determine acoustic wave irradiation intensity.

[0034]

The first step of preparation can be implemented, for example, by storing a table showing association between the analysis items and irradiation positions in the storage unit 12, and by searching the irradiation position corresponding to a particular analysis item, as shown in Fig. 3(a). Or it can also

be implemented as follows: As shown in Fig. 3(b), a table showing association between the required amount of specimens and reagents for each analysis item is stored in the storage unit 12. The amounts of specimens and reagents corresponding to a particular analysis item are searched from this table. Then the liquid level in the reaction vessel 21 of the agitated substances (specimen and reagent) is calculated to determine the irradiation position based on the obtained liquid level.

[0035]

The second step of preparation can be implemented, for example, by storing a table showing association between the analysis items and irradiation intensities in the storage unit 12, and by searching the irradiation intensity corresponding to a particular analysis item, as shown in Fig. 3(c). Especially, the irradiation intensity is preferred to be changed according to the reagent. Consequently, it can also be implemented by the following procedure: As shown in Fig. 3(d), the table showing the association between the information on each reagent and acoustic wave irradiation intensity is stored in storage unit 12, and irradiation intensity corresponding to a particular reagent is searched from this table.

[0036]

For the irradiation position and irradiation intensity, it is also possible to take the following procedure: Multiple types of specified values are prepared as parameters in advance, and the optimum one of these parameters is selected with consideration given to kinetic characteristics of the agitated substance such as viscosity and surface tension. The selected value is described in the table. Especially, parameters of irradiation intensity are preferred to be parameters including irradiation time, not frequency or voltage.

[0037]

Those tables are stored in the storage unit 12 by manual reading of the operator or automatic reading.

[0038]

The above two steps of preparation allows the agitating mechanism 7 to provide effective agitation in conformance to analysis item.

[0039]

Namely, when the reaction vessel 21 is fed to the point of agitation and is stopped there, agitating mechanism controller 15 controls the piezoelectric element 30 to ensure that acoustic wave irradiated from the electrode 32 which irradiates acoustic wave

to the irradiation position determined in the first preparatory step in conformance to the command of the controller 13 through piezoelectric element driver 14 will have the irradiation intensity determined in the second step of preparation. As described above, acoustic wave is applied to the gas/liquid liquid level of the object to be agitated having the level different in conformance to the analysis item. Acoustic wave irradiation intensity is selected with consideration given to kinetic characteristics such as viscosity and surface tension of the agitated substances, thereby ensuring effective agitation to be performed.

[0040]

In the above-mentioned embodiment, irradiation intensity is determined using the table stored in the storage unit 12. In another embodiment, it is possible to use information recorded in the reagent bottle 1.

[0041]

For example, the barcode showing irradiation intensity of acoustic wave is pasted on each reagent bottle 18. A barcode reader to read it can be installed close to the reagent disk 2. Similarly to the above-mentioned case, for irradiation intensity, multiple types of specified values are prepared as

parameters in advance, and the optimum one of these parameters can be selected with consideration given to kinetic characteristics of the agitated substance such as viscosity and surface tension. Then the barcode showing irradiation intensity can be pasted. Also similarly to the above case, parameters of irradiation intensity are preferred to be a combination of parameters including irradiation time, not frequency or voltage.

[0042]

This allows the same barcode to be pasted on the reagent having the same irradiation intensity. It also allows the reagents bearing the same barcode to be handled collectively. This will result in reduced amount of information; hence, reduced loads of storage unit 12 and controller 13.

[0043]

In still other embodiment, it is possible to use the information entered by the operator through the input unit 11, without using the information assigned to the reagent bottle 18.

[0044]

Similarly to the above, for irradiation intensity in this case, multiple types of specified values are prepared as parameters in advance, and the optimum one

of these parameters can be selected by the operator with consideration given to kinetic characteristics of the agitated substance such as viscosity and surface tension. Also similarly to the above case, parameters of irradiation intensity are preferred to be a combination of parameters including irradiation time, not frequency or voltage. A combination of these parameters can be selected as one parameter by the operator. This does not required the complicated work to be done by the operator.

[0045]

In the above-mentioned embodiments, agitation is conducted at only one position. Agitation can be made at two or more places, depending on the system size. For example, piezoelectric element 30 can be installed on the bottom of the reaction bath 4 to allow simultaneous irradiation of acoustic wave to the side and bottom surface of the reaction vessel 21 from both the side and bottom.

For example, assume an analysis item which requires use of two or more types of reagents, and two or more reagent inlet positions. To ensure that agitation is carried out every time reagent is poured through each reagent inlet position, two or more positions for agitation can be provided.

[0046]

[EFFECTS OF THE INVENTION]

As described above, when the specimen and reagent poured into a reaction vessel are to be analyzed, the present invention allows agitation to be carried out by irradiation of acoustic wave, without contacting the specimen and reagent in the reaction vessel. At the same time, it ensures an effective agitation for each object to be analyzed.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a perspective view representing the configuration of an automatic analyzer related to the embodiment according to the present invention;

Fig. 2 is an vertical cross sectional view around the agitation mechanism of an automatic analyzer related to the embodiment according to the present invention; and

Fig. 3 is an illustration representing the configuration of various tables related to the embodiment according to the present invention.

[DESCRIPTION OF NUMERALS]

1. Specimen disk

2. Reagent disk

3. Reaction disk

4. Reaction bath

5. Sampling mechanism

6. Pipetting mechanism

7. Agitating mechanism

8. Photometric mechanism

9. Cleaning mechanism

10. Display unit

11. Input unit

12 Storage unit

13 Controller

14. Piezoelectric driver

15. Agitating mechanism controller

16. Specimen vessel

17. Circular disk

18. Reagent bottle

19. Circular disk

20. Cold reserver

21. Reaction vessel

22. Reaction vessel holder

23. Drive mechanism

24. 77. Probe

25. 28. Bearing shaft

26. 29. Arm

30. Piezoelectric electron

31. Stationary unit

32. Electrode

33. Nozzle

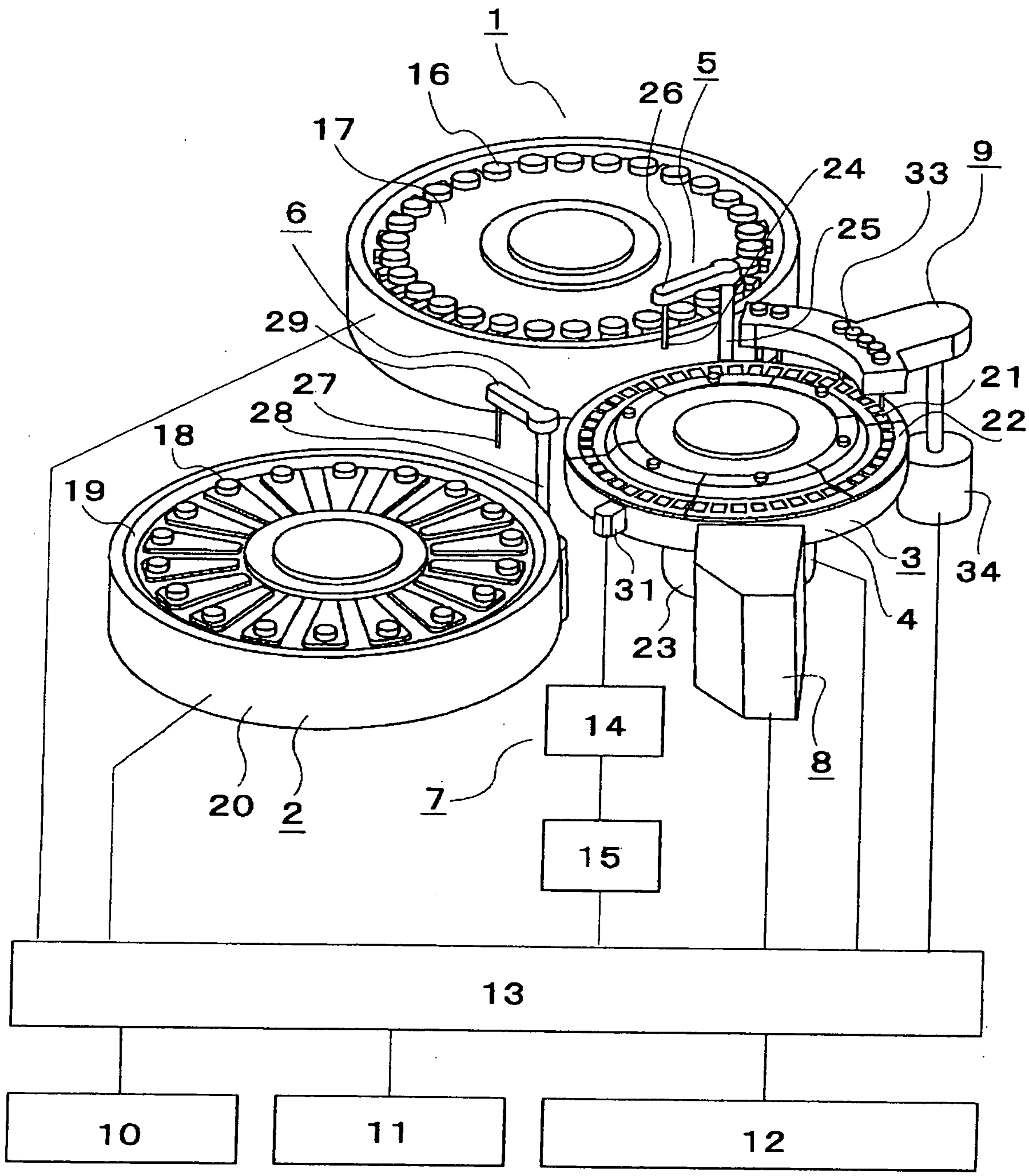
34. Vertical drive mechanism

【書類名】図面　(DOCUMENTS NAME) DRAWINGS

【図１】(Fig. 1)

Fig. 1

図1



【図２】(Fig. 2)

Fig. 2
図2

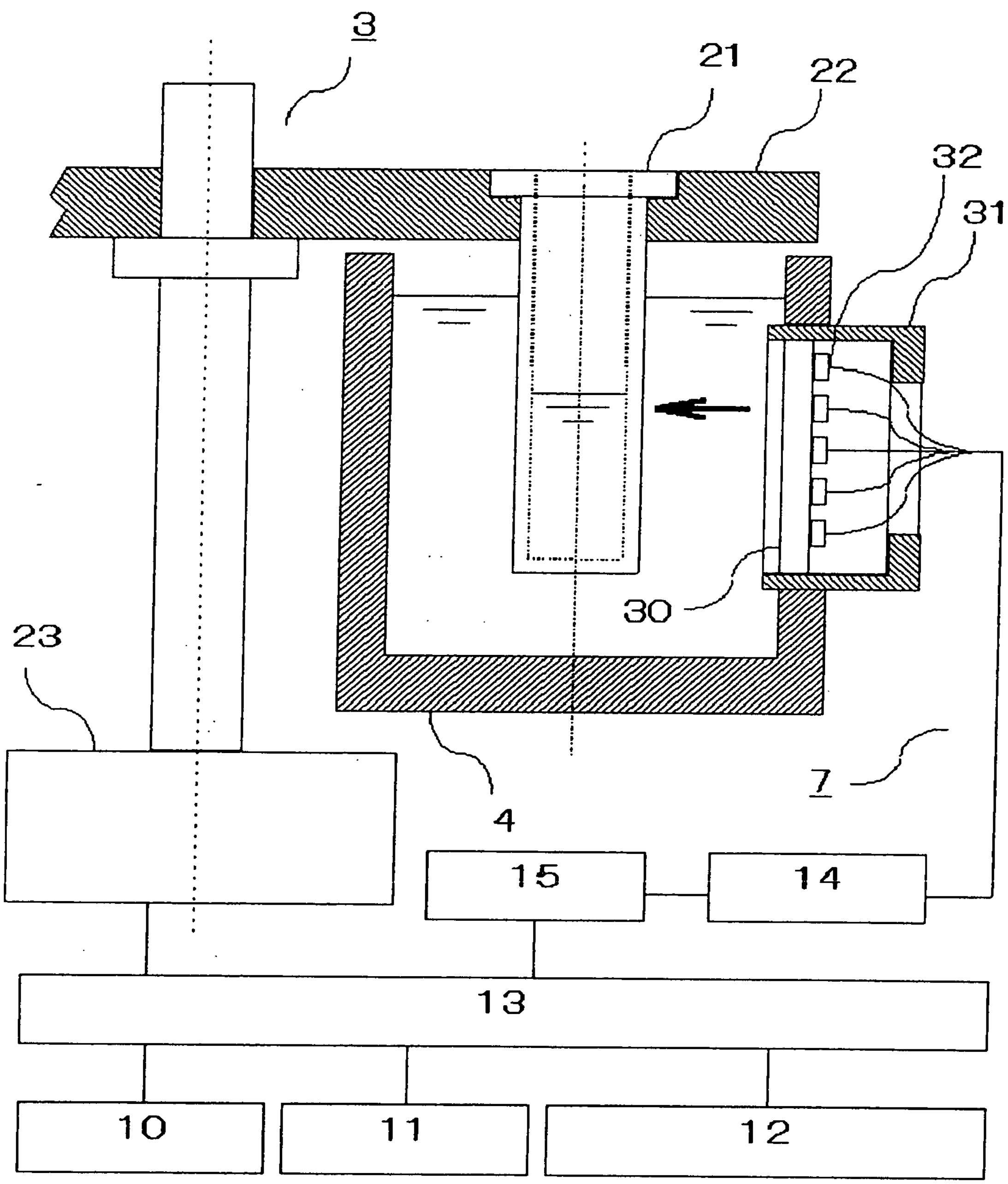


FIG. 3(a)

ANALYSIS ITEM	IRRADIATION POSITION
ANALYSIS ITEM A	IRRADIATION POSITION A
ANALYSIS ITEM B	IRRADIATION POSITION B
⋮	⋮

(b)

ANALYSIS ITEM	SAMPLE QUANTITY	REAGENT QUANTITY
ANALYSIS ITEM A	QUANTITY AA	QUANTITY aa
ANALYSIS ITEM B	QUANTITY BB	QUANTITY bb
⋮	⋮	⋮

(c)

ANALYSIS ITEM	IRRADIATION INTENSITY
ANALYSIS ITEM A	IRRADIATION INTENSITY A
ANALYSIS ITEM B	IRRADIATION INTENSITY B
⋮	⋮

(d)

REAGENT DATA	IRRADIATION INTENSITY
REAGENT DATA A	IRRADIATION INTENSITY A
REAGENT DATA B	IRRADIATION INTENSITY B
⋮	⋮

[ABSTRACT]

[OBJECT]

The object of the present invention is to provide an automatic analyzer which, when the specimen and reagent poured into a reaction vessel are to be analyzed, allows agitation to be carried out by irradiation of acoustic wave, without contacting the specimen and reagent in the reaction vessel. At the same time, it ensures an effective agitation for each object to be analyzed.

[MEANS OF ATTAINING THE OBJECT]

The above object can be attained by the present invention providing an automatic analyzer designed to analyze the specimen and reagent poured in the reaction vessel 21; wherein said analyzer comprises a means to analyze the physical properties of the specimen, and an agitation mechanism 7 installed outside said reaction vessel 21 to agitate the specimen and reagent poured in said reaction vessel 21 by irradiation of acoustic wave toward said reaction vessel 21; and acoustic wave irradiation position and irradiation intensity are controlled for each object to be analyzed.

[SELECTED DRAWING] Fig. 1

CERTIFICATE OF TRANSLATION

I, Akio Matsuzawa, of 2582-37, Migawa-cho, Mito-shi, Ibaraki 310-0913, Japan, hereby state that I am familiar with the Japanese and English languages. I further certify that the attached English translation of Japanese Patent Application JP 2000-54955 is an accurate translation in the English language.

Dated this 24th day of October, 2007

Akio Matsuzawa

Akio Matsuzawa